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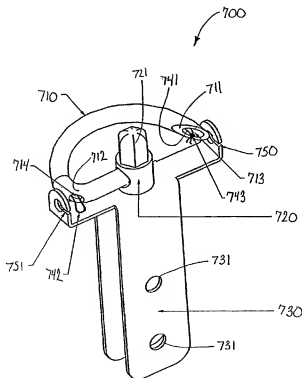
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 (71) Applicant (for all designated States except US): **BIOMEDDEX, S.A. [CH/CH]; 14 quai du Seujet, CH-1201 Geneva (CH)**
 (72) Inventor; and
 (75) Inventor/Applicant (for US only): **GODIN, Norman [US/CH]; 14 quai du Seujet, CH-1201 Geneva (CH)**
 (74) Agent: **BELLES, Brian, L.; Cozen O'Connor, 1900 Market Street, Philadelphia, PA 19103 (US)**
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[Continued on next page]

(54) Title: IMPROVED APPARATUS AND METHOD FOR SECURING TO AN INTERNAL WALL OF A BIOLOGICAL LUMEN



(57) **Abstract:** An improved apparatus and method for securing to an internal wall of a biological lumen. In one aspect the invention is an apparatus comprising: a curved needle having a lead end and a trailing end, the curved needle pivotable about an axis between an open position and a closed position and adapted to pierce and engage the internal wall of the lumen when pivoted from the open position to the closed position; a needle cavity extending through the curved needle; a loop of string having a rear portion and a forward portion having a snag; and the loop of string positioned within the needle cavity at or near the lead end of the curved needle. In another aspect, the invention is a method of securing the inventive apparatus to the internal wall using solely the loop of string.



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DEVICE FOR SECURING TO WALL OF INTERNAL LUMEN

Cross Reference to Related Application

[0001] This application is a continuation-in-part of, and claims priority, to PCT/US03/15731, filed May 20, 2003, which is hereby incorporated by reference in its entirety.

Field of the Invention

[0002] This invention relates generally to the field of internal medical devices, and specifically to methods and apparatus for securing medical devices to the internal walls of biological lumens.

Background Art

[0003] Medical devices are inserted into biological lumens for a variety of reasons. For example, in the treatment of gastroesophageal reflux disease (GERD), a medical prosthesis, such as that shown in United States Patent 5,861,036, Godin, is inserted into the esophagus. In order to prevent gastric juices from refluxing into the esophagus and causing esophageal mucosal injury ("esophagitis"), the medical prosthesis must remain properly positioned within the esophagus.

[0004] Getting medical devices, such as a prosthesis used to treat GERD, to remain properly positioned within a body lumen for an extended period of time has proven to be a significant challenge in the medical field. While ensuring that devices are properly sized has helped reduce the problem, it is still common for internal medical devices to shift and/or disengage from their proper position within the biological lumen despite proper sizing. Current methods for securing medical devices to the internal wall of the desired lumen include suturing, gluing, and using suction/aspiration. However, none of these techniques have proven to be satisfactory.

- [0005] Glues, such as cyanacrylates, are commonly used to secure medical devices to the internal wall of the desired biological lumen by applying the glue to the exterior of the medical device and holding the device in contact with internal wall. Using glues presents a number of problems. First, glues dry very quickly and can result in the medical device prematurely bonding in an undesired orientation. Once adhered, glues are not easily reversible and further moving the medical device is difficult. Additionally, glues can cause problems when being handled with an endoscope. Often the endoscope or optics can end up being glued to the medical device itself or the optics of the endoscope can be opacified by the glue itself.
- [0006] Suturing is another method of securing medical devices to the internal wall of a biological lumen. Suturing is unsatisfactory in that space can be very limited within the lumen, causing the suturing job to be very difficult. This can result in the doctor obtaining a less than optimal suture. Additionally, suturing is usually done by suctioning tissue and placing a needle and thread through the suctioned tissue. Thus, the sutures are usually not place very deep and fall out easily and fairly rapidly.
- [0007] Another method that exists for securing medical devices within the lumen is the use of aspiration/suction to induce a proturbence of the mucosa into a cavity of the medical device. Such a method is disclosed in United States Patent 6,285,897, Kilcoyne, which is hereby incorporated by reference. Suction has proven to be unsatisfactory in that the medical device will slough off with the mucosa in a matter of days and can not be used to secure the medical device to the internal wall for an extended duration.

Disclosure of the Invention

- [0008] It is therefor an object of the present invention to provide a method and apparatus for insertion into a biological lumen that more securely engages an internal wall of the biological lumen.
- [0009] Another object is to provide a method and apparatus for insertion into a biological lumen that can remain secured to the internal wall of the biological lumen for an extended period of time.

- [0010] Yet another object is to provide a method and apparatus for insertion into a biological lumen that remains properly positioned.
- [0011] A further object of the present invention is to provide a method and apparatus for insertion into a biological lumen that can be easily secured to the internal wall of the biological lumen.
- [0012] A still further object is to provide a method and apparatus for insertion into a biological lumen that can be easily removed from the internal wall of the biological lumen after it is secured thereto.
- [0013] Still another object is to provide a method and apparatus for insertion into a biological lumen that does not interfere with an endoscope or other optics while being secured to the internal wall.
- [0014] It is a further object to provide a method and apparatus for insertion into a biological lumen that provides minimal discomfort to the patient and quick healing.
- [0015] These objects and others are met by the present invention, which in one aspect is an apparatus for securing to an internal wall of a biological lumen comprising: a curved needle having a lead end and a trailing end, the curved needle pivotable about an axis between an open position and a closed position and adapted to pierce and engage the internal wall of the lumen when pivoted from the open position to the closed position; a needle cavity extending through the curved needle; a loop of string having a rear portion and a forward portion having a snag; and the loop of string positioned within the needle cavity so that the snag protrudes from the needle cavity at or near the lead end of the curved needle. Preferably, the loop of string is positioned in the needle cavity so that the rear portion of the loop of string protrudes from the needle cavity at or near the trailing end of the curved needle.
- [0016] The term biological lumen as used herein is meant to include body cavities and/or orifices. The biological lumen can be, for example, the stomach, colon, rectum, bladder, uterus, vagina, biliary ducts (including the common bile duct), or blood vessels. When the biological lumen is the esophagus, the apparatus will be an anti-reflux device, such as that disclosed in United States Patent 5,861,036 or United States Application Publication 2003/0009236, both

of which are incorporated by reference herein. The term "esophagus" in this discussion includes the lower esophageal sphincter (LES).

- [0017] The depth of the suture formed by the present invention depends on the radius of the curved needle (i.e., the curvature of the needle). The curvature can be adapted so as to obtain a depth of the suture that one chooses, resulting in more solid sutures that last longer.
- [0018] The snag in the forward portion of the loop of string can be a simple knot tied into the string. Preferably, the string is surgical thread, size 2.0. The snag is preferably sized so that it does not fit into the needle cavity. Sizing the snag so that it can not fit into the needle cavity prevents the loop of string from being pushed into the needle cavity during piercing of the internal wall by the curved needle.
- [0019] Preferably, the apparatus has a body to which the curved needle is pivotally mounted. The body can be a clip body that is then secured to a medical device or the body can be portion of the medical device itself. In this embodiment, a first post is preferably supplied on the body for receiving and securing the forward portion of the loop of string. A second post is also preferably provided on the body for receiving and securing the rear portion of the loop of string. The first and second posts can be substantially C-shaped. This allows the loop of string to be adequately secured to and removed from the posts easily. The suture formed by the loop of string can be easily cut at the C-shaped posts with existing endoscopic suture cutting devices.
- [0020] The curved needle is preferably designed so that it is removable from the body. This can be accomplished by pivotally mounting the curved needle to the body with a tight fit or pop-fit assembly, such as a stub and cavity. In order to facilitate rotation of the curved needle about its axis, the curved needle preferably extends from a hub that is adapted to be engaged by a rotational tool. For example, the top of the hub can be shaped as a bolt head.
- [0021] In another aspect, the invention is a method of securing an apparatus to an internal wall of a biological lumen. According to the inventive method, the apparatus is first provided comprising a curved needle pivotally mounted to a body, the curved needle having a lead end and a trailing end, the curved needle

pivotable about an axis between an open position and a closed position and adapted to pierce and engage the internal wall of the lumen when pivoted from the open position to the closed position, a needle cavity extending through the curved needle from the lead end to the trailing end, a loop of string having a rear portion and a forward portion having a snag, the loop of string positioned within the needle cavity so that the snag protrudes from the needle cavity at or near the lead end of the curved needle and the rear portion of the loop of string protrudes from the needle cavity at or near the trailing end of the curved needle. The apparatus is inserted into the desired biological lumen with the curved needle in the open position. Once in the desired position within the lumen, the curved needle is pivoted about the axis to the closed position thereby causing the curved needle to pierce and engage the internal wall. As such, the leading end of the curved needle re-enters the internal space of the lumen and the forward portion of the loop of string is secured to a first post or the body. The curved needle is then rotated back to the open position, causing the loop of string to slide out of the needle cavity. Once back in the open position, the rear portion of the loop of string is secured to a second post. As such, the apparatus will be supported solely to the internal wall by the loop of string which extend through the path initially formed by the curved needle. The curved needle can then be removed from the body and taken out of the lumen to prevent obstruction.

[0022] Preferably, the lumen is an esophagus and the apparatus is an implantable anti-reflux device.

Brief Description of the Drawings

[0023] Figure 1 is a side view of a balloon catheter positioned in an esophagus.

[0024] Figure 2 is a top perspective view of a clip assembly having a pivotable curved needle according to one embodiment of the present invention.

[0025] Figure 3 is an exploded view of the clip assembly embodiment of FIG. 2.

[0026] Figure 4 is a perspective view an endoscopic rotational tool about to engage the clip assembly of FIG. 2 connected to a section of a wall of an anti-reflux prosthesis.

- [0027] Figure 5 is a side, partially cut-away view of an anti-reflux prosthesis, partially in section, according to an embodiment of the present invention inserted within an esophagus, illustrated in cross-section
- [0028] Figure 6 is a perspective view of an embodiment of a clip assembly according to the present invention with a female socket.
- [0029] Figure 7 is a perspective view a clip assembly incorporating a hollow curved needle and a loop of string according to another aspect of the present invention.
- [0030] Figure 8 is a perspective view of a section of a wall of an anti-reflux prosthesis having the clip assembly of FIG. 7 connected thereto and positioned within an esophagus, the curved needle being in the open position.
- [0031] Figure 9 is a perspective view of the anti-reflux prosthesis of FIG. 8 wherein the curved needle is in the closed position and a forward portion of the loop of string is being secured to a C-shaped post.
- [0032] Figure 10 is a perspective view of the anti-reflux prosthesis of FIG. 8 wherein the curved needle is removed from the clip body and the loop of string is secured to both C-shaped posts.
- [0033] Figure 11 is a perspective view of the loop of string removed from the needle cavity of the clip assembly of FIG. 7 according to an embodiment of the invention.

Modes for Carrying Out the Invention

- [0034] Referring first to FIG. 1, a balloon catheter is inserted into esophagus 30 to determine the size of esophagus 30 and thereby the proper size of the ring of the anti-reflux prosthesis 400 (FIG. 5) for insertion. Balloon catheter 10 comprises balloon 11, syringe 12 and pressure monitor 13 (illustrated as a generic box). In order to determine the diameter of the internal wall 31 of esophagus 30, balloon 11 is inserted into esophagus 30 until it reaches the location to be sized. Once in position, balloon 11 is inflated by depressing plunger 14 of syringe 12 which is filled air, oxygen, or some other gas. Balloon 11 is inflated by syringe 12 until balloon 11 contacts internal wall 31 of esophagus 30. Upon contacting internal wall 31 of esophagus 30, an increase in pressure is detected by pressure monitor 13. The volume of air

supplied to balloon 11 by syringe 12 is recorded and correlated to a specific balloon diameter. This diameter is used to choose an appropriately sized anti-reflux prosthesis for insertion into esophagus 30. Balloon 11 is deflated and removed from esophagus 30.

- [0035] Referring now to FIGS. 2 and 3, an embodiment of a clip assembly 200 comprises clip body 210, curved needle 220, stopper 230, hub 240, and sleeve 250. Clip body 210 is a rigid structure and comprises top plate 211, front plate 212, and back plate 213. Front plate 212 and back plate 213 have teeth 215. Teeth 215 are adapted to secured clip assembly 200 to wall 610 (FIG. 4) of anti-reflux device 400 (FIG. 5) by either biting into wall 610 or fitting into corresponding indentations.
- [0036] Referring to Fig. 3, curved needle 220 is substantially semi-circular shaped and protrudes from side wall 243 of hub 240. Hub 240 also comprises cylindrical stub 241 protruding from its bottom. Sleeve 250 forms sleeve cavity 251. Sleeve 250 is positioned between front plate 212 and back plate 213 so that sleeve cavity 251 is substantially aligned with hole 214 of top plate 211. When assembled, cylindrical stub 241 extends through hole 214 of top plate 211 and into sleeve cavity 251 of sleeve 250. Cylindrical stub 242 is sized and shaped to form a tight fit with sleeve cavity 251 while still allowing rotation/pivoting therewith. As such, curved needle 220 is pivotally connected to clip body 210, allowing rotation/pivoting about axis A-B.
- [0037] Referring now to FIG. 4, hub 240 also comprises bolt head 242. As illustrated in FIG. 4, bolt head 242 is adapted to be engaged by rotational tool 350 so that curved needle 220 can be rotated about axis A-B (FIG 3) in both a clockwise and counterclockwise direction. Curved needle 220 is illustrated in a closed position. If curved needle 220 is rotated 180 degrees counterclockwise, it would be an open position. When in the open position (NOT illustrated), no portion of curved needle 220 extends beyond outer surface 611 of wall 610. When curved needle 220 is in the open position and bolt head 242 is rotated in a clockwise direction, curved needle 220 will rotate in a clockwise direction until it contacts stopper 230. Once curved needle contacts

stopper 230, stopper 230 prevents curved needle from rotating any further in the clockwise direction.

[0038] In another embodiment, stopper 230 can be adapted so as to not interfere with the rotation of curved needle of 220 about axis A-B. In this embodiment, sleeve 250 can be adapted to act as a stopper if desired. Additionally, sleeve 250 can be sized so that the tight fit between cylindrical stub 241 and sleeve cavity 251 does not allow free rotation of curved needle about axis A-B without force being exerted by rotational tool 350.

[0039] Clip assembly 200 is secured to wall 610 of anti-reflux prosthesis 400 through the use of teeth 215, as is illustrated in FIG. 4. Anti-reflux prosthesis 400 is inserted into an esophagus 30 with all of the curved needles 220 in an open position. In FIG 5 the curved needle 220 illustrated on the left is shown in the open position. When in the open position, curved needle 220 does not engage internal wall 31 and does not interfere with the insertion/placement of anti-reflux prosthesis 400 in esophagus 30.

[0040] In operation, the anti-reflux prosthesis 400 is first positioned in the desired location within esophagus 30, and then each curved needle 220 is pivoted about axis A-B from the open position to a closed position. The curved needle 220 illustrated on the right is shown in the closed position. As curved needle 220 is pivoted from the open position to the closed position, curved needle 220 pierces and engages internal wall 31, securing anti-reflux prosthesis in place. Once secured to internal wall 31, anti-reflux prosthesis 400 can be removed by pivoting all of the curved needles 220 back into the open position. All pivoting of curved needle 220 within esophagus 30 can be accomplished with rotational tool 350 (FIG. 4) through the use of an endoscope.

[0041] In another method of using the present invention, anti-reflux prosthesis 400 is inserted and positioned within esophagus 30 with each curved needle 220 in the closed position. This closed orientation ensures that curved needle 220 does not prematurely pierce or cut internal wall 31 during insertion and positioning. Once inserted, each curved needle 220 will be rotated 360 degrees in the appropriate direction instead of 180 degrees.

- [0042] Referring now to FIG. 6, hub 240 can be modified to be compatible with any type of rotational device. As illustrated, hub 240 can have a female socket 245 instead of a bolt head for facilitating pivoting of curved needle 220. The female socket 245 can receive a male-ended rotational device rather than a female-ended device 350.
- [0043] Figures 7-11 illustrate a clip assembly according to another aspect of the present invention. The clip assembly of FIGS. 7-11 uses an alternative method and design to secure a device to the internal wall of the lumen.
- [0044] FIG. 7 illustrates clip assembly 700 in a closed position. Clip assembly 700 comprises hollow needle 710 extending from hub 720. Hollow needle 710 is pivotally mounted to clip body 730 in a manner similar to that described above. Clip body 730 comprises connection holes 731 for facilitating connection to the medical device to be secured within a lumen.
- [0045] Hollow needle 710 comprises leading end 711 and trailing end 712. A needle cavity extends through hollow needle 710 from opening 713 at leading end 711 to opening 714 at trailing end 712. Hub 720 comprises bolt-head 721 for engagement by a rotational tool so that hollow curved needle 710 can be pivoted between an open position (FIG. 8) and the closed position.
- [0046] Referring now to FIG. 11, a single loop of string 740 is positioned within and extends through the needle cavity of hollow needle 710. Loop of string 740 comprises a forward portion 741 and rear portion 742. Forward portion 741 comprises a knot 743 tied therein. Loop of string 740 is preferably made out of size 2.0 surgical threading. However, the present invention is not limited to the string being of any specific size or type of material, so long as the material is qualified for internal use. As used herein, a "loop of string" encompasses string formed into a single loop or string having a loop formed at each of its ends.
- [0047] Referring back to FIG. 7, loop of string 740 is positioned within the needle cavity so that its forward portion 741 protrudes from opening 713 while its rear portion 742 protrudes from opening 714. Knot 743 is preferably sized to not fit within opening 713. As such, knot 743 will act as a snag, preventing forward portion 741 from getting pushed into and trapped in the needle cavity.

As used herein, a "snag" encompasses any device or item that can be placed onto or incorporated into loop of string 740 that will help prevent the forward portion 741 from getting jammed into the needle cavity.

[0048] Posts 750 and 751 are located on clip body 730. Posts 750 and 751 are substantially C-shaped. As such, forward and rear portions 741 and 742 of loop of string 740 can be easily placed over the posts and adequately secured thereto. However, the posts can be any shape such as linear, curved, or a combination of the two. Alternatively, the posts do not have to be located on a clip body but can be built into the body of the medical device itself.

[0049] FIG. 8 illustrates clip assembly 700 secured to wall 810 of an anti-reflux prosthesis. Clip assembly 700 is in the open position. In using clip assembly 700 to secure an anti-reflux prosthesis to internal wall 910 of esophagus 900, clip assembly 700 is first attached to wall 810 of the anti-reflux prosthesis using connection holes 731. The anti-reflux prosthesis is then inserted into esophagus 900 until it is at the desired position. Curved needle 710 remains in the open position during insertion.

[0050] Once the anti-reflux prosthesis is in the desired position, curved needle 710 is rotated clockwise with a rotational tool that engages bolt head 721. As curved needle 710 is rotated clockwise, lead end 711 (FIG. 7) of curved needle 710 pierces and travels through wall 910. As curved needle 710 continues to be rotated clockwise toward the closed position, lead end 711 exits wall 910 near post 750. Knot 743 on loop of string 740 prohibits the string from getting jammed into the needle cavity during rotation.

[0051] Referring now to FIG. 9, curved needle 710 is illustrated in the closed position after rotation from the open position. Once in the closed position, forward portion 741 of string of loop 740 is near post 750 while rear portion 742 is near post 751. Forward portion 741 is then grasped by endoscopic forceps and placed over post 750. Once forward portion 741 is secured to substantially post 750, curved needle 710 is rotated counter-clockwise back to the open position using the rotational tool. As curved needle 710 is rotated back to the open position, the loop of string 740 pulls out of the needle cavity because forward portion 741 is secured to post 750. Once curved needle 710

is back into the open position and loop of string 740 is pulled entirely out of the needle cavity, rear portion of loop of string 740 is grasped by endoscopic forceps and placed over post 751.

[0052] FIG. 10 illustrates loop of string 40 secured to both posts 750 and 751. As such, the anti-reflux prosthesis is secured to wall 910 solely by loop of string 740. Once loop of string 740 is properly secured to posts 750 and 751, curved needle 710 is removed from clip body 730 with an endoscopic snare and removed from the esophagus. Curved needle 710 is pivotally mounted to clip body 730 in a removable fashion through the use of stub 722 which pop-fits into hole 770.

[0053] While the invention has been described and illustrated in sufficient detail that those skilled in this art can readily make and use it, various alternatives, modifications, and improvements should become readily apparent without departing from the spirit and scope of the invention. Specifically, the use of a clip body is not necessary and the body of the medical device itself can be adapted to pivotally mount the curved needle.

Claims

What is claimed is:

1. An apparatus for securing to an internal wall of a biological lumen comprising:

a curved needle having a lead end and a trailing end, the curved needle pivotable about an axis between an open position and a closed position and adapted to pierce and engage the internal wall of the lumen when pivoted from the open position to the closed position;

a needle cavity extending through the curved needle;

a loop of string having a rear portion and a forward portion having a snag;
and

the loop of string positioned within the needle cavity so that the snag protrudes from the needle cavity at or near the lead end of the curved needle.

2. The apparatus of claim 1 wherein the snag is sized to not fit into the needle cavity.

3. The apparatus of claim 1 further comprising a body, the curved needle being pivotally mounted to the body.

4. The apparatus of claim 3 wherein the body is a clip body adapted to be secured to a medical device.

5. The apparatus of claim 3 wherein the body is a body of a medical device.

6. The apparatus of claim 3 further comprising a first post on the body for receiving and securing the forward portion of the loop of string.

7. The apparatus of claim 6 further comprising a second post on the body for receiving and securing the rear portion of the loop of string.

8 The apparatus of claim 7 wherein the first and second posts are substantially C-shaped.

9. The apparatus of claim 3 wherein the curved needle is removable from the body.

10. The apparatus of claim 9 wherein the curved needle is pivotally mounted to the body by a tight-fit or pop-fit assembly.

11. The apparatus of claim 1 wherein the curved needle extends from a hub adapted to be engaged by a rotational tool.

12. The apparatus of claim 1 wherein the snag is a knot.

13. The apparatus of claim 1 wherein the loop of string is positioned in the needle cavity so that the rear portion of the loop of string protrudes from the needle cavity at or near the trailing edge of the curved needle.

14. An apparatus for securing to an internal wall of a biological lumen comprising:

a curved needle having a lead end and a trailing end;

the curved needle pivotally mounted to a body for rotation about an axis between an open position and a closed position, the curved needle adapted to pierce and engage the internal wall of the lumen when pivoted from the open position to the closed position;

a needle cavity extending through the curved needle;

a loop of string having a rear portion and a forward portion having a knot that is sized to not fit into the needle cavity;

the loop of string positioned within the needle cavity so that the knot protrudes from the needle cavity at or near the lead end of the curved needle and

the rear portion of the loop of string protrudes from the needle cavity at or near the trailing end of the curved needle;

a first post on the body for receiving and securing the forward portion of the loop of string;

a second post on the body for receiving and securing the rear portion of the loop of string; and

wherein the first and second posts are substantially C-shaped.

15 A method of securing an apparatus to an internal wall of a biological lumen comprising:

providing an apparatus comprising a curved needle pivotally mounted to a body, the curved needle having a lead end and a trailing end, the curved needle pivotable about an axis between an open position and a closed position, a needle cavity extending through the curved needle from the lead end to the trailing end, a loop of string having a rear portion and a forward portion having a snag, the loop of string positioned within the needle cavity so that the snag protrudes from the needle cavity at or near the lead end of the curved needle and the rear portion of the loop of string protrudes from the needle cavity at or near the trailing end of the curved needle;

inserting the apparatus into the biological lumen with the curved needle in the open position;

pivoting the curved needle about the axis to the closed position thereby causing the curved needle to pierce and engage the internal wall;

securing the forward portion of the loop of string to a first post on the body;

pivoting the curved needle back to the open position; and

securing the rear portion of the loop of string to a second post on the body.

16. The method of claim 14 wherein the first and second posts are substantially C-shaped.

17. The method of claim 14 further comprising the step of removing the curved needle from the body and out of the lumen.

18. The method of claim 14 wherein the snag is a knot.

19. The method of claim 14 wherein the lumen is an esophagus and the apparatus is an implantable anti-reflux device.

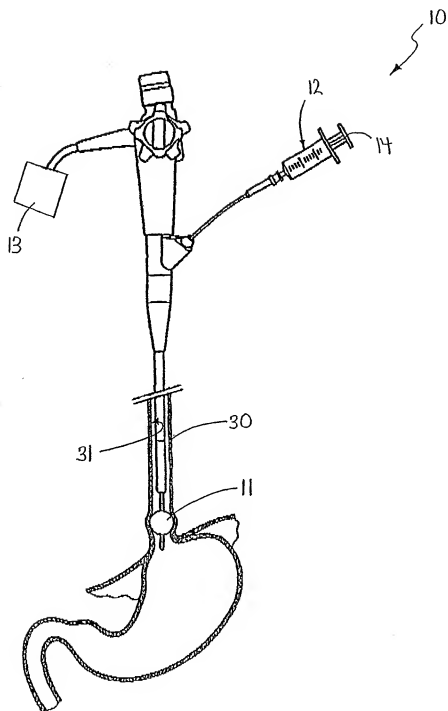


Fig. 1

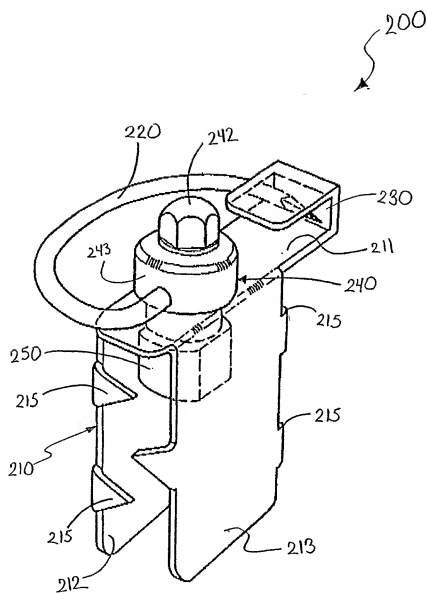


Fig. 2

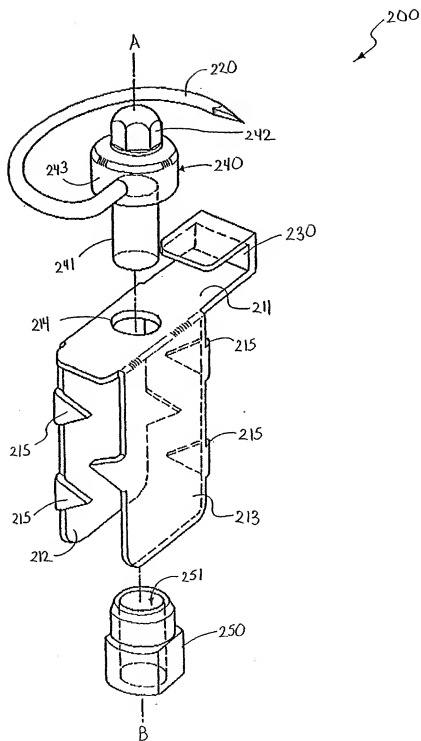


Fig. 3

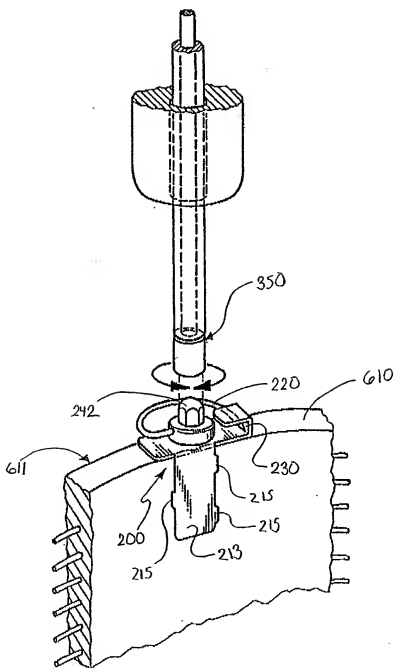


Fig. 4

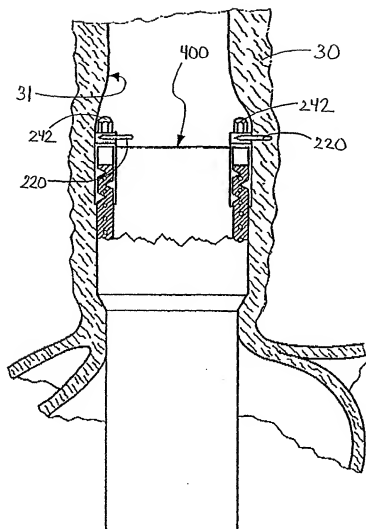


Fig. 5

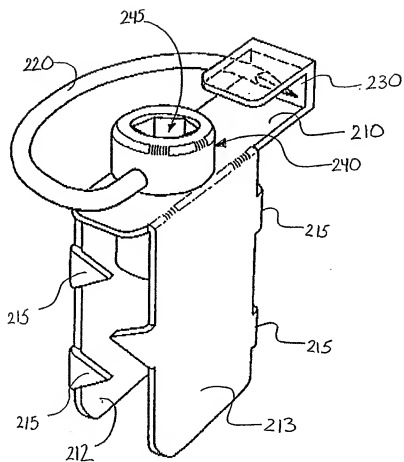


Fig. 6

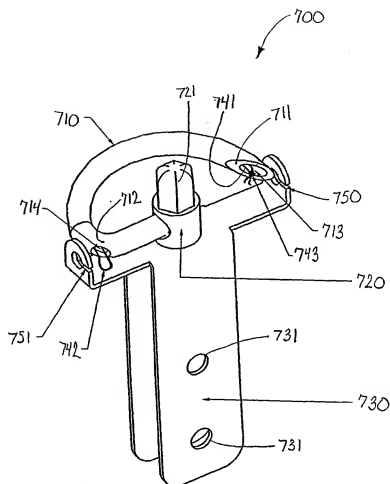


Fig. 7

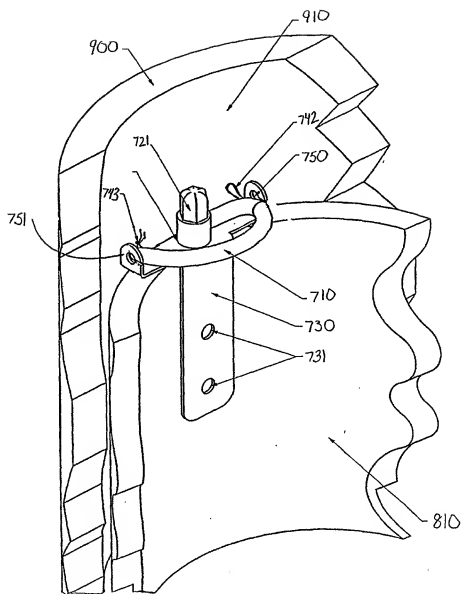


Fig. 8

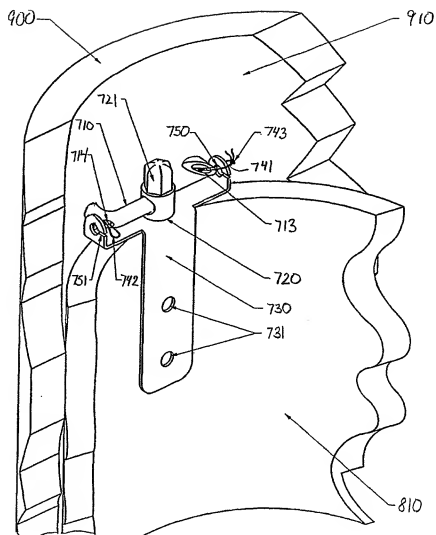


Fig. 9

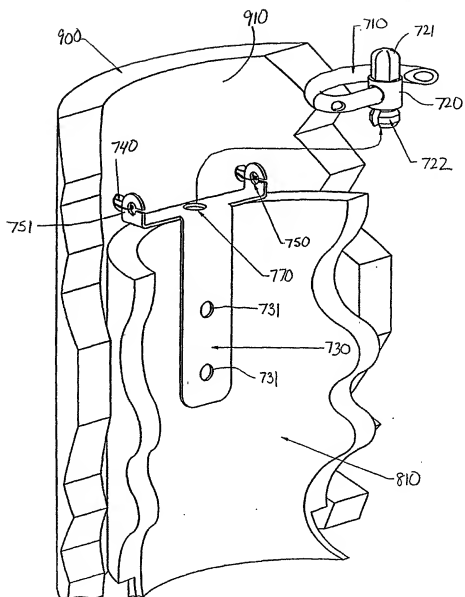


Fig. 10

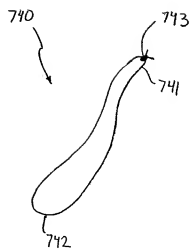


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/01601

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61F 2/04

US CL : 623/23.64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 623/11.11, 23.64, 23.65; 600/037

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,254,642 B1 (TAYLOR) 03 July 2001 (03.07.2001), see entire document.	1-19
A	US 6,004,347 A (MCNAMARA ET AL) 21 December 1999 (21.12.1999), see entire document.	1-19
A	US 5,314,473 A (GODIN) 24 May 1994(24.05.1994), see entire document.	1-19

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A"

document member of the same patent family

Date of the actual completion of the international search

23 July 2004 (23.07.2004)

Date of mailing of the international search report

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Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
Facsimile No. (703) 305-3230

Authorized officer

John P Lacyk

Telephone No. 308-0858

Sheikh H. Venky
Paralegal Specialist
Tech. Center 3700